

Endorsement of Global Ocean Mapping Project

Now that the surfaces of the Moon, Mars, Venus, the moons of the outer solar system, and the subaerial Earth have been mapped systematically at high spatial resolution, why not our own Earth's ocean floors?

Some 370 million km² of our planet, almost equal in area to two moons and two Mars-sized planets, are water-covered, and seafloor mapping efforts (for practical reasons, acoustic, sonar images, and topographic contours) have yielded only an irregular patchwork of disparate data, with large areas of remote seafloor remaining almost entirely unmapped.

An international, long-term Global Ocean Mapping Project (GOMaP) was considered and endorsed as important and technologically feasible at a recent meeting sponsored by the U.S. Naval Research Laboratory (NRL) with assistance from the Office of Naval Research (ONR).

Forty researchers and other ocean floor mapping experts from academia, government agencies, and private industry agreed that the technology was mature and the time was right—given the end of the Cold War, the good economy, and the pressing societal and research needs for greater knowledge of the oceans—for the world's nations to cooperate in launching GOMaP.

The workshop participants agreed that GOMaP was feasible with current marine technology and data handling capabilities and required only the necessary political will to undertake a project that would cost U.S. \$10–20 billion and take several decades to complete.

Workshop speakers enumerated GOMaP's societal benefits, in addition to greatly increased basic geological knowledge, including the likelihood of many new discoveries. The assembled experts agreed that societal benefits would be important in "selling" the GOMaP concept.

Such benefits include improved assessments of seafloor and sub-bottom geologic resources, including methane hydrates; commercial and recreational fin and shellfish habitat mapping; geologic risk assessments (for example, submarine landslides, earthquake fault activity, tsunamis, and submarine volcanism); navigation hazards; and others. The workshop attendees agreed that GOMaP should have a strong educational and outreach component, providing opportunities for academic researchers, students, and science teachers to ride the research ships and share in the research process.

GOMaP could learn from NASA how to quickly disseminate information; for example, by putting new images on the Web and beam-ing real-time results into the world's classrooms.

The GOMaP meeting considered the Gulf of Mexico and the small Juan de Fuca tectonic plate—which lies off Oregon, Washington, and British Columbia—as the two leading candidates for "pilot" U.S. GOMaP areas. The Gulf of Mexico, rich in methane seeps, mass-wasting, and salt tectonics, would be a great locale for U.S. cooperation with Mexico and perhaps Cuba; while the Juan de Fuca plate, a good "microcosm" of the world's ocean-floor geologic settings, would be mapped by Canada and the United States.

Mapping this plate in detail as a part of GOMaP would optimize subsequent placement of seafloor sensors and observatories, and data interpretation and modeling, under the proposed "NEPTUNE" Project. Some workshop attendees also supported the idea of starting GOMaP in a very remote ocean area to maximize the harvest of new knowledge.

Mapping the deep ocean floor from surface ships is done with either hull-mounted or towed sonar arrays, which nowadays return both swaths of topographic seafloor contours and also swaths of acoustic backscatter imagery. Such ocean-floor data are analogues to what has been measured from spacecraft circling above dry planets and moons with scanning altimeters, imaging radars (the subaerial Earth and Venus), or digital "cameras" imaging in backscattered sunlight (Moon, Mars, etc.). However, GOMaP ships would simultaneously collect many other kinds of data as well; for example, the strength of the gravity and magnetic fields, seismic subbottom profiles, and meteorological, oceanographic, and biological observations. Any and all instruments or sensors could be "piggy-backed," providing their deployment does not compromise the basic seafloor mapping mission.

Time, Cost Estimates

GOMaP would take roughly 225 ship years for the 90% of the world ocean deeper than 500 m. If the U.S. University National Oceanographic Laboratory System (UNOLS) vessels or commercial vessels with similar costs are employed, it would cost about \$25–\$50 per square kilometer, or about \$8–\$16 billion to map our planet's whole deep-water ocean. Contributions of ship time by nations with lower labor costs, as well as economy of scale factors, would reduce this cost.

Workshop representatives of companies that survey fiber optic cable routes pointed out that GOMaP might utilize—on an opportunity basis, at favorable rates—otherwise idle ship time

between commercially contracted surveys. Given the size of the seafloor mapping fleet and competing requirements for such large, deep-sea vessels, it might reasonably take 20–30 years to map the ocean floors beyond the 500-m depth contour. The relative advantages of towed and hull-mounted swath-mapping systems were debated at the workshop, with the majority agreeing with the experts that hull-mounted is the best way to go at present, primarily due to smaller positioning errors of data on the seafloor. However, towed systems were not written off, in view of possible future advances.

The GOMaP workshop participants also considered using deep-diving unmanned underwater vehicles (UUVs) to map the deep-ocean seafloor at much higher resolution than is possible from surface ship or surface-towed sonar systems. Most attendees agreed that the best use for such technology, which is still in the development stage, is for detailed follow-up investigations of interesting features discovered by the GOMaP project. However, if GOMaP looks like it will become a reality, UUV technology development would be accelerated, and it may be possible to field mother ships with small fleets of UUVs that return for data download and battery recharge at staggered intervals.

Mapping the shallowest 10% of the world ocean probably offers the greatest practical benefits to mankind but presents special technological and political problems. Over 500 ship years would be necessary to map the shallowest 10% of the oceans due to the progressive narrowing of data swath widths with decreasing water depth. However, smaller vessels with lower day-rates would be used to map the shallower seafloor, which mostly lies nearer to the coasts and supporting port facilities.

Moreover, GOMaP workshop attendees heard presentations of how the shallowest 50 m—at least those covered by relatively clear water—could also be mapped by aircraft using laser scanning bathymetry and hyperspectral imaging. About one-third of the ocean area is covered by Exclusive Economic Zones (EEZs), which extend seaward from the shores of coastal nations out to the edges of the continental shelves and beyond. Some of these coastal states may initially reject offers to help map their EEZs, although data and expertise would be shared at no charge and the mapping effort would not compromise national claims. Certain other areas may at least initially be kept off-limits to systematic surveying for reasons of military or political security.

The workshop attendees agreed that the coverage must be systematic and complete—that is, adjacent swaths of sidescan sonar and swath bathymetry must abut or overlap without any data gaps between the swaths. There was further agreement on the need for data

quality control and quality assurance; at a minimum, a GOMaP cruise would need to collect data across a test area before heading out to its "survey box."

The GOMaP workshop ended before the issue of data standards had been worked out; however, attendees agreed to continue this discussion after the meeting adjourned. Data and survey standards, once adopted, will determine which, if any, ocean areas have already been mapped to the required standards.

GOMaP workshop attendees represented a number of universities and two cable-route surveying companies. Included were representatives from the Naval Research Laboratory, U.S.

Geological Survey, National Oceanic and Atmospheric Administration, National Imagery and Mapping Agency, NASA's Jet Propulsion Laboratory, Naval Oceanographic Office, Office of Naval Research, Naval Meteorology and Oceanography Command, and the Oceanographer of the Navy.

The National Science Foundation representative could not attend but did submit a statement.

In addition to the U.S. attendees, two scientists from Canada and one from the United Kingdom participated. All workshop attendees endorsed the GOMaP concept and promised to "spread the gospel." Speakers agreed to contribute to a white paper in the

months following the workshop and to help plan for an international, open-to-all symposium to further develop the GOMaP concept into a plan of action to be submitted to government leaders.

The Global Ocean Mapping Project workshop was held in Bay St. Louis, Mississippi, June 12–14, 2000.

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